

Navy Collaborates, Monitors to Better Understand

SEA TURTLE *movements* in San Diego Bay

Satellite Tagging May Provide Clearer Picture of Threatened Species

Since the closure of a power plant in the southern part of San Diego Bay, a collaborative monitoring effort among the Navy, the National Marine Fisheries Service (NMFS) and others has been underway to better understand changes in the movement and behavior of the green sea turtle so that the Navy and this turtle can continue to share the resources in the bay.

San Diego Bay is home to one of the largest U.S. Navy complexes in the world and California's second largest incorporated city. Today, more than 25 percent of the U.S. Navy fleet is homeported in San Diego. Maintaining readiness in this ecosystem without causing harm to the natural resources is an ongoing challenge. There are a variety of threatened and endangered

species that rely on the San Diego Bay ecosystem at different stages of their lives. One of these is the East Pacific green sea turtle.

The East Pacific green sea turtle is a federally threatened species in San Diego Bay. While the majority of the population has traditionally lived in the quieter south part of the bay, the turtles may be venturing into areas more frequently used for U.S. Navy, recreational, and commercial activities. An increased presence of turtles outside of the southern portion of the bay may have potential implications for management of this species, as there is a higher likelihood of boat strikes and other potentially adverse human interactions.



Green sea turtles have inhabited San Diego Bay since at least the mid-1800s.

Green sea turtles have inhabited San Diego Bay since at least the mid-1800s. They have most frequently been observed in the southern section of the bay, known as the South Bay, most of which is designated as the San Diego Bay National Wildlife Refuge. The South Bay is well suited to support this turtle population because it is shallower than the central and northern parts of the bay, has a smaller shipping channel, and extensive eelgrass beds. Another attraction for the turtles until recently was the warm waters heated by the effluent from the fossil fuel-based South Bay Power Plant (SBPP) in Chula Vista.

A Habitat Within a Habitat

The SBPP, in operation from 1960 to 2010, discharged warm water into the South Bay. The outfall area released water used to cool plant generators, producing water temperatures consistently in the green turtle's comfort range (59 degrees Fahrenheit) during operation of the plant. Automated monitoring conducted by underwater hydrophones found that when the SBPP was in operation, turtles consistently and frequently used the warm water outfall area. Additionally, as a result of the warm waters from the power plant, a study published in 2012 indicated the turtles in the South Bay grow faster than green sea turtle populations elsewhere in similar temperate zones.

Since the plant's closure, the waters are returning to their natural ambient temperature. Given that turtles demonstrate strong site fidelity to habitats, it may be that turtles are presently adjusting to the "new normal" of their environment in the South Bay. However, preliminary research has shown that some turtles are moving beyond the South Bay into other areas of the bay. These areas are much more heavily used by U.S. Navy, commercial, industrial, and recreational boaters. This is problematic because vessel collisions are

a known source of turtle mortality in other parts of the world, as is entanglement in fishing gear.

To a lesser extent, construction activities have been known to have some effect on turtle behavior and such activities are more prevalent in the central and northern sections of the bay. Naval operations in San Diego Bay frequently necessitate pile driving for routine in-water infrastructure construction and maintenance. Current in-water naval projects include the replacement of a fuel pier, the installa-



A green sea turtle on the jetty near the site of the former power plant in the South Bay.

NMFS permit #16803

tion of at least three boat lifts at Naval Base Point Loma, and the demolition and replacement of a pier at Naval Base San Diego. These in-water construction projects in San Diego Bay require consultation under the Endangered Species Act (ESA) with the National Marine Fisheries Service (NMFS) to determine whether such activities “may affect, but are not likely to adversely affect” green sea turtles. These consultations often require conditions to help minimize or avoid construction-related interactions with sea turtles. For example, when these or any in-water pile construction activities are performed at Navy facilities, spotters are assigned to visually sweep a 120 to 130 meter area for green sea turtles. If turtles are seen, prior to or during pile activity, work will not continue until the animal is known to leave the area or at least 15 minutes have passed since the last sighting.

Although these are the current NMFS-approved management practices, it is unknown how turtle behavior may be altered with water temperature changes, and what adjustments may need to be made to these and other human uses of the bay. It continues to be in the best interest of the Navy to remain a strong team partner with NMFS to better understand changes in turtle behavior or movements to preserve the Navy mission.

Given the conservation concerns regarding the federally threatened East Pacific green turtle, reducing threats to these turtles in their foraging areas is imperative. Management strategies must be able to accommodate shifts in movement and habitat use of this foraging population of turtles. For example, if automated monitoring reveals that the turtles are active at night, construction activities could continue to take place outside of these known foraging hours. Such strategies



cannot be formulated however, without sufficient knowledge of these behavioral patterns.

Past & Current Monitoring Efforts

Green turtles have been monitored in San Diego Bay since the 1970s beginning with researchers at San Diego State University (SDSU). The monitoring program evolved into a collaborative effort headed by the NMFS Marine Turtle Ecology and Assessment Program based at the Southwest Fisheries Science Center (SWFSC) in La Jolla, California. Recent monitoring efforts have included NMFS collabora-

The Basics About the GREEN SEA TURTLE

WEIGHING UP TO 600 pounds, the green sea turtle (*Chelonia mydas*) is one of the largest sea turtles in the world. It inhabits tropical and subtropical coastal waters around the world. Unlike most sea turtles, it occasionally clambers onto land to sunbathe. Another fairly unique characteristic of the green sea turtle is its diet—adults are largely herbivorous, feeding on sea grasses and algae. Juvenile green turtles will also eat invertebrates like crabs, jellyfish, and sponges.

The green sea turtle is named for the color of its fat, not its shell, which is typically brown or olive. Green turtles vary in size and shape around the world, but the East Pacific green turtle is particularly different. These turtles are darker in color with a different shaped shell and display a myriad of behaviors, many of which are not seen in green turtles elsewhere.

Green turtles, like other sea turtles, migrate from feeding sites to nesting grounds approximately once every three years, where they lay their eggs on sandy beaches. The green sea turtles that inhabit San Diego Bay are known to travel to Mexico to nest.

The green sea turtle is harvested for eggs and food in many parts of the world. Other green sea turtle parts are used for leather, and small turtles are sometimes stuffed and sold as souvenirs. Incidental catch in commercial shrimp trawling is an increasing source of mortality.



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Some turtles were found to regularly inhabit the waters off of Naval Base Coronado.

tions with SDSU, Space and Naval Warfare Systems Center Pacific, Naval Facilities Engineering Command Southwest, and the Unified Port of San Diego.

Before the SBPP closed, passive sonic telemetry technology was utilized to track turtle movements in the bay. Beginning in 2006, researchers deployed stationary hydrophone receiver stations in various locations throughout the South Bay. From four years of passive acoustic monitoring efforts conducted pre-power plant closure, researchers discovered regular turtle movement habits. Generally, the power plant outfall and eelgrass beds in the South Bay were the mostly commonly used areas and were frequented during dawn and dusk. During the day, turtles were often present in the Sweetwater Marine Terminal and designated boating lanes in the South Bay. There were also a few turtle detections in the central part

of the bay near Naval Amphibious Base Coronado in 2007 and 2008.

In addition to the passive acoustic monitoring efforts, seven satellite tags were attached to turtles in San Diego Bay from 2007 to 2009. Those data are now being analyzed.

The first attempt to study turtle movement patterns post-power plant closure included a combination of continued passive sonic telemetry as well as active tracking of turtles.

Out of an estimated 60 to 80 turtles who lived in the bay, a total of 21 were successfully tracked over the course of one year (2011–2012). Turtles were actively tracked via boat surveys on a bi-monthly basis. The data gathered through these surveys allowed the researchers to estimate and map the home range for four of the most commonly tracked turtles. As in the past, data were also gathered passively via underwater

receivers. Those receivers were placed in the South Bay in locations similar to the 2006–2010 monitoring efforts. Additional receivers were deployed in the northern and central portions of the bay as well as on either side of the mouth of the bay to track animals who headed for open waters.

The results of the one year effort concluded that green sea turtle populations were still most heavily concentrated in the south part of the bay, and that habitat use had not yet changed since the closing of the power plant. However, some turtles were found to regularly inhabit the waters off of Naval Base Coronado, the site of a large bed of eelgrass. In the past, turtles had only been documented in this area on a few occasions. Turtles were still regularly detected around the Sweetwater Marine Terminal and the South Bay boating channels, with one sighting in open water north of the Coronado



A green sea turtle enters San Diego Bay in 2012 wearing an acoustic monitoring tag. NMFS permit #16803



Researchers prepare to weigh a green sea turtle.
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A researcher from SWFSC reads a flipper tag. The white cloth is placed on the turtle's head to help keep it calm.
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Bridge—all areas in which high recreational, industrial, and naval boat traffic occur.

The research team also noted disparities between data gathered via active and passive monitoring methods. This is most likely due to limitations in the performance capabilities of passive receivers in deep or fast-moving water. For a clearer picture, the team recommended satellite tagging for continuing efforts.

Post-Power Plant Closure Satellite Tagging Begins

A satellite tagging effort, funded by Commander, Navy Installations Command (CNIC), Commander, U.S. Pacific Fleet, and the Port of San Diego, began in 2013 and is currently underway.

In conjunction with SWFSC, turtles were captured in accordance with NMFS permit specifications and National Oceanic and Atmospheric Administration Institutional Animal Use and Care protocols. Turtles were measured and weighed, and a Global Positioning

System (GPS)-enabled satellite transmitter was attached to the animal's shell. The tags transmit the animal's position via either GPS or Argos satellite when it surfaces.

Tag transmitter data provide information on how turtles utilize their local habitat, with particular emphasis on their proximity to high Navy-use areas and previously identified areas adjacent to the former power plant. Movements are also correlated with eelgrass coverage data and time of day/night in order to get a better picture of what the turtles are doing and when they are doing it. These types of data will better inform users of the bay to minimize impacts to this species.

Between 2013 and 2014, ten turtles were tagged in the initial effort. Preliminary results appeared to indicate a behavioral difference between an adult turtle who had

The Basics About the SOUTH BAY POWER PLANT

OPENED IN 1960, the SBPP provided electricity to the growing San Diego region for the better part of four decades. At its peak capacity, it generated 700 megawatts of electricity. However, in 1999 San Diego Gas & Electric sold the plant to the Port of San Diego. The Port's eventual goal was demolition, as soon as state regulators determined that the plant was no longer needed for the regional power grid.

By 2005, the plant was operating at reduced capacity, mainly at peak times of the year. In December 2010, regulators determined that the plant was no longer needed and it was immediately decommissioned. The complex was demolished by implosion in 2013. The site is now part of the Chula Vista Bayfront, a planned 500-acre mixed use development.

Tag transmitter data provide information on how turtles utilize their local habitat.



A researcher applies epoxy to a sea turtle's back in preparation for affixing a satellite tag. NMFS permit #16803



After epoxy is applied, a satellite tag is attached. NMFS permit #16803

likely lived in the bay since the power plant was in operation, and a juvenile who may have entered the bay post-plant closure. The adult stayed closer to the South Bay range, while the juvenile traveled throughout the bay and north to the Los Angeles area—the northernmost point of the range for green sea turtles. Although these satellite data are still being analyzed, there has been a general shift in turtle distribution as compared to the 2007–2009 satellite tag data. The post-closure population has shifted to an adjacent South Bay location.

As the water temperature regimes in the bay continue to return to normal, and turtles adjust to these changes, continued use of satellite tagging is imperative to determine whether the preliminary movements are indicative of the population as a whole.

Why Monitoring is Necessary

The monitoring of the green sea turtle in San Diego Bay directly supports Sections 7(a)(1) and 4 of the ESA which directs federal agencies to implement a conservation program for federally listed species. The act also requires that federal agencies must consult with NMFS and/or U.S. Fish and Wildlife Service (USFWS) to ensure that their actions do not jeopardize the continued existence of the protected species.

Information collected under the satellite tagging project will support these consultations and will be incorporated into National Environmental Policy Act documentation, including environmental impact statements.

The current tagging project also supports the NMFS recovery plan for the U.S. Pacific populations of the green turtle. In this plan, an action was identified to determine population size and status through regular monitoring and census-taking. Adherence to this recovery plan is a component

The Basics About SATELLITE TAGGING

SATELLITE TAGS HAVE been used on various marine mammals to help determine migratory routes and provide information on foraging patterns. Satellite-linked tags transmit a signal to a satellite, and position data is then relayed to the researcher.

Previously, all satellite tags were compatible only with polar orbiting Argos satellites. These satellites pass over a given area approximately once every 90 minutes, limiting the potential for picking up an animal's signal to these brief periods. New technology has provided an interface with GPS satellites, greatly improving tracking ability.

In addition to location, the satellite tags used by the current research team deliver such information as water temperature, which helps paint a picture of sea turtle habits and preferences.



With the satellite tag in place, a green sea turtle returns to the bay. NMFS permit #16803.

of San Diego Bay's Integrated Natural Resources Management Plan (INRMP).

The San Diego Bay INRMP is unique in that it's the only Department of Defense INRMP that manages a body of water. The implementation success of the INRMP is due to the successful partnership between the Navy and the Port of San Diego, a non-Federal signatory on the plan. This project addresses several specific concerns detailed in the INRMP regarding the management of naval activities that may affect the threatened green sea turtle. Two of these include:

1. Providing information about the turtle's home range and foraging patterns in order to delineate and protect the range of habitat.
2. Addressing the impacts of potential reduction or fragmentation of turtle forage habitat.

Additionally, the SWFSC will continue to conduct other types of research on the San Diego Bay green sea turtle



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population, such as genetics and population structure, demography, growth, diet and foraging ecology, long-distance migrations, health, and mortality, which will all contribute to the in-depth understanding of the population and will aid in management of the species.

Proper management of U.S. Navy activities in the vicinity of the green sea turtle will help the bay continue to avoid critical habitat designation under Section 4 of the ESA. Critical habitat is defined as “a specific

geographic area(s) that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection.”

If critical habitat were designated in San Diego Bay, it could result in modifications to training schedules, the temporary closing of specific areas, or restrictions on activities in areas where turtles may occur.

Continued investigation of the current home range shift of green sea turtles is necessary to manage this threatened species and to avoid critical habitat designation. Data from these projects will inform future consultations for facilities projects and will also contribute to the Navy's training range sustainment program known as the Tactical Theatre Training, Assessment and Planning (TAP) Program. [↕](#)

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The Basics Behind LISTING

THE ESA DEFINES an endangered species as “one that is in danger of extinction throughout all or a significant portion of its range.” A threatened species is “one that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range.” NMFS determines which protections are required for most marine species and USFWS determines which protections are required for land and freshwater organisms, as well as sea otters, polar bears, and manatees. In the case of sea turtles, NMFS regulates activities which may affect sea turtles in the water and the USFWS regulates activities which may affect sea turtles while on land, particularly when nesting.

To better address management of green turtles, NMFS and the USFWS are considering separating the species into 11 distinct population segments (DPS). These designations are based on species biology and genetics, and are intended to offer different levels of protection to various geographical groups. This action removes the current range-wide listing and, in its place, lists eight DPSs as threatened and three as endangered.